Body size of orthoconic cephalopods from the late Silurian and Devonian of the Anti-Atlas (Morocco)

Pohle, Alexander ; Klug, Christian

Abstract: Fluctuations in body size of orthoconic cephalopods are reported from late Silurian to Late Devonian sediments at several locations in the Tafilalt and in the Dra-Valley (Anti-Atlas, Morocco). The combination of measurements of diameters and apical angles allows the reconstruction of their total conch size (length and volume), which revealed a strongly right-skewed size distribution with an average length of 278 mm, while the largest Devonian actinocerids exceeded 2 m. Within the examined groups (Actinocerida, Orthocerida, Pseudorthocerida), there is no uniform trend, but rather frequent fluctuations with maximum sizes in the late Lochkovian and early Emsian. Body size decreased in times of extinction events, while stable periods are mostly associated with a size increase. Additionally, conch size correlates well with gamma diversityand global d13C values. Furthermore, the apical angle and septal diameter of orthocones appear to correlate, but only when their mean values are compared across beds. Anti-Atlas, body size, Cephalopoda, Devonian, extinction events, Morocco, orthocones.

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Body size of orthoconic cephalopods from the late Silurian and Devonian of the Anti-Atlas (Morocco)

Alexander Pohle[1] & Christian Klug[1]

[1] *Paläontologisches Institut und Museum, Universität Zürich, Karl-Schmid-Strasse 4, 8006 Zürich (alexander.pohle@pim.uzh.ch)*

Orthoconic cephalopods are very common, sometimes even dominant elements of marine Palaeozoic strata. As such, they can be used to statistically adress palaeontological questions based on large numbers of specimens (e.g., Wendt 1995). Some orthocones are known to have reached very large sizes of up to 6 meters in length (Teichert & Kummel 1964, Klug et al. 2015). However, usually only the extreme sizes are reported, so it is not possible to tell from the literature, whether the average conch size increased as well. In our study we examined size distributions by measuring a large number of specimens in consecutive layers in several locations in the Anti-Atlas of Morocco (Pohle & Klug 2017). Most of the included specimens belong to the Orthocerida, a couple of them to the Pseudorthocerida and only very few to the Actinocerida, Bactritida and Lituitida.

The results show that body size of orthoconic cephalopds was subject to considerable fluctuations in late Silurian to Late Devonian sediments of the study area. The combination of measurements of diameters and apical angles allows the reconstruction of their total conch size (length and volume), which revealed a strongly right-skewed size distribution with an average length of 278 mm, while the largest Devonian actinocerids exceeded 2 m in length. Within the examined groups, there is no uniform trend, but rather frequent fluctuations with maximum sizes in the late Lochkovian and early Emsian. Body size decreased in times of global transgressions or extinction events (House 2002), while more stable periods are mostly associated with a size increase. The relationship between body size and these events is further corroborated by the strong correlation of conch size with gamma diversity and global $\delta^{13}C$ values (Figure 1). A more enigmatic result is the negative correlation between apical angle and septal diameter of orthocones, but this relationship is only observed when their mean values are compared across beds.

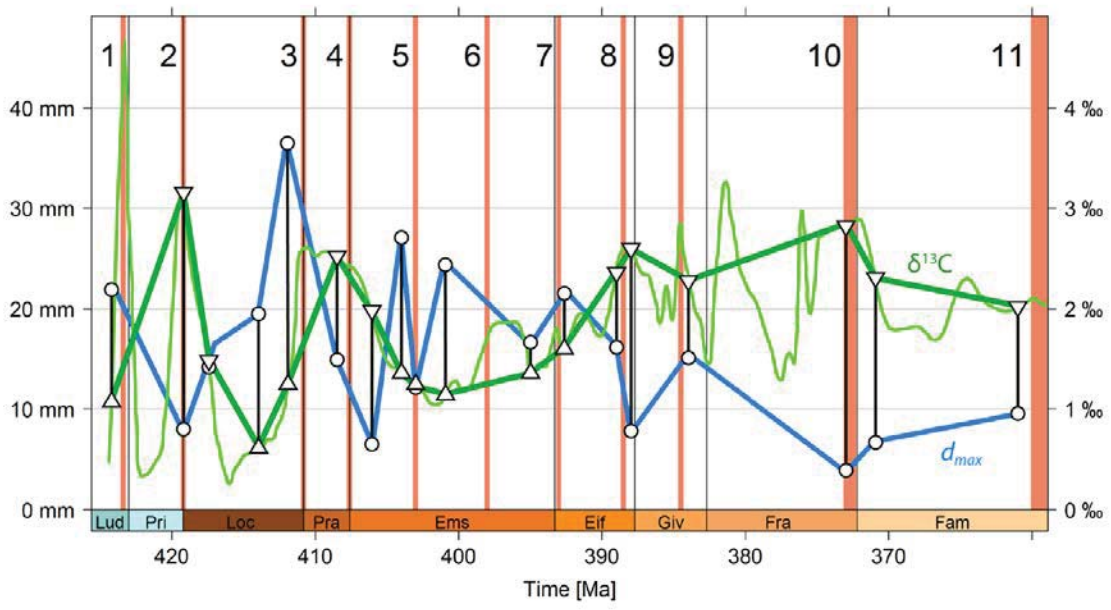

Figure 1. Mean phragmocone diameter (d_{max}) of orthoconic cephalopods, showing its strong correlation to global $\delta^{13}C$ values (Spearman's rank correlation r_s = -0.76, P = 0.0003) and extinction events (vertical bars). Circles: samples of orthocones. Triangles: approximate global mean $\delta^{13}C$ –value at the same point in time. 1. Lau event., 2. Klonk event, 3. End-*pesavis* event, 4. Zlíchov event, 5. Chebbi event, 6. Daleje event, 7. Choteč event, 8. Kačák event, 9. Taghanic event, 10. Kellwasser event, 11. Hangenberg event. Source: Pohle & Klug (2017).

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